

DISPO Advisor - Expert System For Psychiatric Disposition

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Abstract

An expert system was designed to assist psychiatric residents at the Johns Hopkins Hospital. This microcomputer based decision support system helps residents find the proper disposition for patients who come to the emergency room. The system uses an inexpensive, commercially available expert system shell, VP-EXPERT by Paperback Software, to match patients with inpatient and outpatient resources appropriate to their needs. The inference engine uses both forward and backward chaining, and interfaces with data stored in DBase III files. The system is currently in daily use by residents.

Introduction

Discharge dispositions for psychiatric patients seen in consultation at the Johns Hopkins emergency room are complex. The consultation service operates 24 hours a day and employs a rotating staff of resident psychiatrists. Over the course of a year, the consultation service sees about 2500 patients. About 25% of patients require hospitalization. The remaining patients are referred to outpatient programs. Psychiatrists not only refer patients and families to mental health facilities, but to a wide variety of social service agencies as well. Referral decisions are based on frequently changing rules. Individual psychiatrists often have trouble remembering and keeping up to date with these rules. Improper triaging results in extra work for the resident staff and inconvenience and frustration for the patients.

The form of the disposition problem is that of a classification model (Weiss and Kulikowski, 1984). As discussed by Weiss and Kulikowski, a classification model requires 3 lists: a list of possible conclusions (the referral facilities), a list of possible observations (data such as the patient's problem or sex) and a list of rules relating observations to conclusions (learned by the psychiatrist from a mentor). Casting the problem as a classification model then suggests that an expert system be used to solve it.

The field of expert systems is expanding rapidly. Textbooks by Buchanan and Shortliffe (1984) or Hayes-Roth, Waterman and Lenat (1983) provide introductions.

In psychiatry, DISPO advisor joins several expert systems such as the "Blue Box" psychopharmacology adviser by Brooks and Heiser (1979) or those which embody the diagnostic rule structure implicit in DSM-III such as those of Zetin et al. (1987) or Greist et al. (1983).

System Description

DISPO Advisor is a collection of thirteen rule-based knowledge bases. Three major categories of resources include those relating to psychiatric problems, alcohol related problems and drug abuse problems. Each of these categories may be handled on an inpatient or outpatient basis thus producing six separate knowledge bases. Other knowledge bases contain information on topics such as soup kitchens, social services, shelters, travel assistance and support groups. In addition to the knowledge bases on specific topics, there is an initial knowledge base that determines *which* knowledge bases should be consulted.

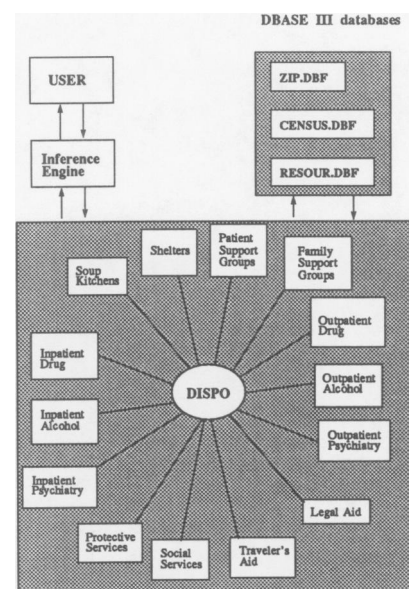


Figure 1

The application uses both forward and backward chaining to determine what resources are available to the patient. Many of the available resources have qualifications that must be met by the patient before acceptance. The goal of the application is to provide information about all applicable resources to the patient.

Each knowledge base must keep track of information about resources including telephone numbers and hours of operation. While the knowledge bases do contain limited information on the other counties in the state of Maryland, the focus of the information is for patients in and around Baltimore City. Since this application has been specifically designed for the Hopkins emergency room, information about the Baltimore area is most complete, but some information specific to outlying areas as well is included.

As explained before, patients seen in the psychiatric emergency room have a diverse group of problems. Typical diagnoses include drug or alcohol intoxication, schizophrenia, depression, family disputes and homelessness. Figure 2 contains some of the typical screening questions asked by the application. Other typical input parameters include inpatient/outpatient status, insurance information, age, sex, and home address.

	Is the patient homeless?
No	Yes
	Does the patient live in Baltimore City?
No	Yes
	Which census tract does the patient live in?
501	
	Is the patient going to be admitted voluntarily (not on certificates)?
No	Yes

Enter to select END to complete /Q to Quit ? for Unknown

Figure 2

To show how an expert system can be beneficial in the emergency room setting, several examples are outlined:

Example 1: In order for a person with insurance to be admitted to a state psychiatric hospital, he must be refused admission by several private hospitals. Each of these private hospitals has different requirements so that the psychiatrist must determine *which* private hospitals might possibly accept the patient, call them to find out whether they *will*, and only call the state hospital if *all* the private hospitals have refused.

Some facilities have unique requirements for admission. Figure 3 shows a rule from DISPO advisor that says the inpatient psychiatric facility GH does not take patients with medical assistance, patients without insurance, patients who are in a health maintenance organization, patients younger than 13 years old, males, or anyone who cannot climb stairs. (This particular hospital does not have an elevator.)

```

RULE FACILITY4
IF   Insurance<>Medical_assistance AND
     Insurance<>None AND
     Insurance<>HMO AND
     Age>=13 AND
     Sex=Female AND
     Can_climb_stairs=Yes
THEN Inpatient_psych_facility=GH;

```

Figure 3

Figure 4 shows the rules regarding admission to Johns Hopkins inpatient psychiatric service. The patient must meet age requirements and have private insurance, or else have medical assistance and live within the catchment area.

```

RULE FACILITY6
IF   Insurance=Medical_assistance AND
     Insurance<>HMO AND
     County=Baltimore_City AND
     Catchment=JHCMHC AND
     AGE>=14
THEN Inpatient_psychiatric_facility=JHH;

RULE FACILITY7
IF   Insurance<>Medical_assistance AND
     Insurance<>HMO AND
     Insurance<>None AND
     AGE>=14
THEN Inpatient_psychiatric_facility=JHH;

```

Figure 4

Figure 5 shows a sample rule for referral to a state hospital. In general, if the patient has medical assistance, he would first be considered for admission to private facilities with requirement rules such as those in Figures 3 and 4, before a rule such as that given in Figure 5 would be applied.

```

RULE FACILITY20
IF   County=Baltimore_City AND
     Catchment=JHCMHC OR
     Catchment=FSKCMHC OR
     Catchment=HBCMHC AND
     Age>=14 AND
     Age<18
THEN Inpatient_psychiatric_facility=CSH;

```

Figure 5

Example 2: To determine the proper outpatient community mental health center for a patient who lives in Baltimore County, his zip code must be found in a table that relates zip codes to community mental health centers.

```

RULE CATCHMENT3
IF   Homeless=No AND
    County=Baltimore
THEN Catchment_known=no
    FIND The ZIP
    GET The ZIP=zip,zip,CMHC
    Catchment=(CMHC);

```

Figure 6

Figure 6 shows the DISPO adviser rule for this case. The combination of the FIND and GET statements query the user for the patient's zip code and look up the proper community mental health center in a DBase III file called ZIP.DBF.

Example 3: If the system is unable to give advice, it should say so.

```

RULE SUGGESTION4
IF   Suggestion_1=No_outpatient_psych_facility
THEN Suggestion_text=No_outpatient_psych_facility
    COLOR=1
    DISPLAY"
    NO OUTPATIENT PSYCHIATRIC FACILITY
    COLOR=15
    DISPLAY"

```

A suitable outpatient facility is not known to this system. Either the data were entered incorrectly (you put in a non-existent census tract for example, or you put in the wrong county) or else the proper disposition is unknown.

If in doubt, try re-running the consultation.

```

    COLOR=14
    DISPLAY"
        Type any key to continue."
    COLOR=15
    CLS;

```

Figure 7

Figure 7 shows a rule that governs the display of a message that says that no resources could be found to satisfy the patient's needs for an outpatient psychiatric facility.

PRIVATE PSYCH HOSPITAL

To arrange admission to a private psychiatric hospital, you need to call the hospital and go through their screening procedure. Usually, the person at the hospital will ask a series of questions and then say that they will get back to you.

Send a DHMH 34 form, certificates and other associated forms if necessary, and copy of the ER record along with the patient.

The ER coordinator will help you get an ambulance to take the person to a private hospital once they have accepted the patient.

Type any key to continue.

Figure 8

Output from the system consists of suggestions (general comments applicable to this case) as well as a list of specific resources for which the patients qualifies. Figure 8 shows a typical suggestion, and Figure 9 shows a typical list of resources with telephone numbers.

INPATIENT RESOURCES		
Anne Arundel General Hospital	301 267-1483	
Fallston General Hospital	301 879-0500	
Franklin Square Hospital	301 682-7832	
Francis Scott Key Medial Center	301 955-0069	955-0074 at night
Gundry Hospital	301 644-3933	
Howard County General Hospital	301 740-7777	
Johns Hopkins Hospital	301 955-5000	
Liberty Medical Center	301 484-2700	484-8282 at night
North Charles General Hospital	301 338-2370	338-2000 at night
Saint Joseph's Hospital	301 377-1580	
Sheppard and Enoch Pratt Hospital	301 823-8200	
Sinai Hospital	301 578-5501	578-5926 at night
Taylor Medical Hospital	301 465-3322	
University of Maryland Hospital	301 328-6231	328-6811 at night
Wyman Park Hospital	301 338-3560	
Highland Health Facility	301 276-7006	

* Type any key to continue..

Figure 9

Implementation

DISPO Advisor is a stand-alone application exclusively used in the emergency room setting. An IBM PC-based solution was selected. Additionally, the initial system costs for PC-based applications are lower than mini- or mainframe-based applications. While there are some limitations imposed on the system design by using a PC, the application is functionally simple.

VP-EXPERT by Paperback Software, was the rule based expert system development tool used for this project. It has a backward and forward chaining inference engine using only production rules (no frames). VP-EXPERT runs on the IBM PC, PC-XT, PC-AT and compatibles such as the AT&T PC 6300, Compaq and Xerox 6065. Features include English-like rules, text and graphic rule traces, optional windows, confidence factors, floating-point math, scientific functions and the ability to run external programs.

A powerful feature of this particular product is the ability to interface with DBF (database) files created using dBASE II, III, III+ or WKS (worksheet) files generated by Lotus 1-2-3. The significance of these interfaces is that they can be used to expand the knowledge base or used to create the rule base. Since dBASE and Lotus have well-known user interfaces, the maintenance of the knowledge base is simplified.

Another feature of VP-EXPERT is the inductive front-end. This front-end can use decision tables from external sources such as text or WKS files and induce its own IF-THEN rules directly. This saves on programming effort by using a tabular form of data entry.

On the whole, VP-EXPERT did the job without serious problems. The software generally worked as advertised and the documentation was of professional quality. The documentation had a complete tutorial on how to use the system and the software included all the program code in the tutorial. The authors of this paper were familiar with basic concepts of expert systems but had no previous programming experience with an expert system shell. It took about 8 hours of time to learn the rudiments of the system so that design work on the project could begin. Knowledge bases were typically designed by assembling a list of examples in a Lotus 1-2-3 spreadsheet and using the inductive front end of VP-EXPERT to generate the initial set of rules before additional rules (more complicated than those processable by the inductive front end) were added. Depending on the complexity of the knowledge base, it typically took 4 to 12 hours to complete the design and testing phase for each of the knowledge bases.

There were no major "bugs" in the software but several minor problems. Error messages were sometimes scant and uninformative. There were undocumented limitations on the length of various system parameters such as the number of items in a menu and the length of various strings. The output control was limited to output of an unjustified string and output of a right justified string--this made for difficulties in the display of tables. There was no choice of which variables interacted between one knowledge base to another; all were functionally global to the entire expert system. This led to problems with the modularity in some knowledge bases since variables used in one knowledge base could influence the behavior of another if the same variable names were inadvertently used. Finally, as the expert system chains from one knowledge base to the next, the screen goes blank. This is sometimes disconcerting to the new user who is concerned that something has gone wrong when he sees a blank screen.

Conclusion

Although testing and refinement are continuing, DISPO advisor is a working prototype. Each knowledge base in DISPO advisor requests answers to 4 or 5 questions per consultation. Given that most consultations do not need to access all knowledge bases and that data from consultations with other knowledge bases are saved when one knowledge base calls another, typical consultations require 10 - 12 answers from the user to establish all appropriate resources. A consultation by an experienced user usually takes less than 2 minutes, well within the constraints established in a busy emergency room where such a tool will be used only if it saves time.

The program was released to the user community in the summer of 1988 and a study of the impact of the system is underway. Immediate goals for continuing work include expansion of the expert system to encompass a broader range of resources and a user survey to document both error rates and suggested enhancements. Also, alternative expert system development tools are being considered since the application is beginning to strain the limits of the present one.

References

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